

How to Make Extra Money **FIXING RADIOS**

NATIONAL RADIO INSTITUTE WASHINGTON, D. C.

No. 29 How To Fix an Intermittent
Receiver

RADIO SERVICING METHODS



NRI TRAINING

Pay A...

Dear Mr. Smith:

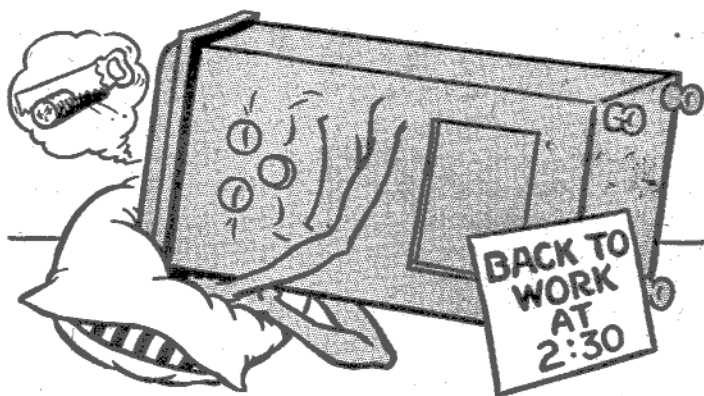
In the year since I graduated, I have earned enough money so that my course, tube checker, multi-meter, signal generator, signal tracer, and a nice stock of tubes and parts are completely paid for out of these earnings. There is also a bank balance of about a hundred dollars left over. All of this work was done in my spare time.

E.J.G., New York



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**NATIONAL RADIO INSTITUTE
WASHINGTON, D. C.**



HOW TO FIX AN INTERMITTENT RECEIVER

INTERMITTENT defects are defined as those defects that are not present all the time. The complaints are the same as the usual ones except for this characteristic, but it very often happens that they are present for such short periods of time that they disappear before one has a chance to localize them. Also, the situation is made more complicated by the fact that attempts to locate the defect will often shock the receiver back into normal operation. This requires somewhat different tactics in localizing the trouble, as we will show. On the average, an intermittent defect will take somewhat longer to localize than a similar permanent defect.

Aside from the fact that they appear and disappear, instead of being permanent, intermittent defects are no different from those you have already studied. A receiver may be intermittently dead, noisy, or weak, or may have intermittent oscillation, hum, or distortion. Always remember this important fact about intermittents—THE SAME GENERAL DEFECTS THAT CAUSE PERMANENT COMPLAINTS ALSO CAUSE THE CORRESPONDING INTERMITTENT COMPLAINTS. Armed with this fact, and with modern service techniques, you can expect to have far less trouble with intermittents than did the "old timers."

Before we study the procedures for locating the causes

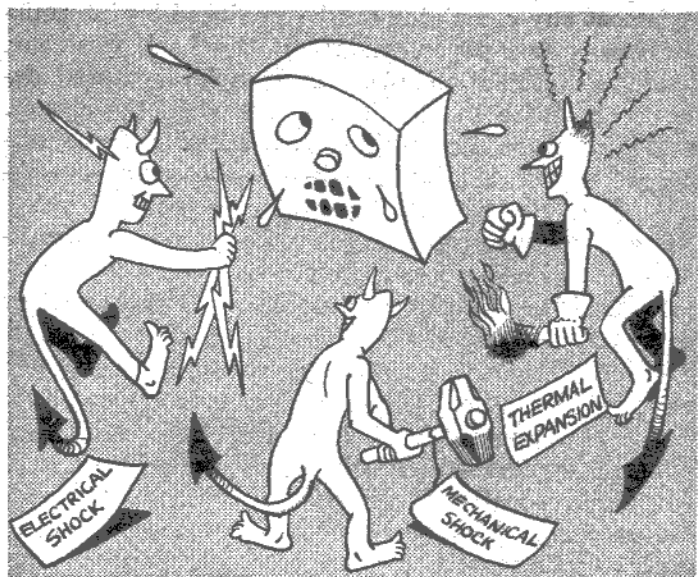
of intermittent complaints, let's see why they occur.

What Causes Intermittents. All intermittent defects are produced by temporary shorts, opens, or leakages. Very often thermal (heat) expansion is responsible for these defects. For example, a metal part in some circuit may be almost touching another part or the chassis; when the receiver is turned on, the chassis and parts become warm, and may expand enough to touch and produce a short. Or there may be a defective connection—a poorly soldered joint, for example—that remains connected as long as it is cool, but opens when the passage of current through the metal heats it enough to cause a slight expansion. Tube electrodes may move slightly when they become warm, perhaps shorting to one another or opening some circuit that should be closed.

Mechanical and electrical actions can also cause intermittents. A jar caused by a passing truck, or even by someone's walking near the set, may open a connection or cause two parts to touch. Sometimes a very small gap exists in a circuit, a gap so small that an arc forms and completes the circuit as long as all voltages are normal. A momentary drop in the supply voltage may quench this arc, producing an open circuit that will close again when the voltage returns to normal or when the receiver is shocked by having the power switch clicked on and off. (Of course, any temporary defect of this latter kind will eventually become permanent, because the arc will eat away the wires at the ends of the gap.)

As you can see, defects that occur in any of the ways just mentioned can often be cured temporarily by the reverse of the effect that causes them. A part that expands when heated will contract when it becomes cool; a part that can be mechanically or electrically jarred loose can be just as readily jarred back again by a succeeding shock; a defect that appears because of some outside influence will disappear when the outside influence is no longer felt. Therefore, it is perfectly possible for an intermittent defect to appear and disappear at frequent intervals—although, in the long run, any such defect will usually become permanent.

Now, let's learn something about how specific parts become defective.



A receiver may become intermittent because of electrical shock, mechanical shock, or thermal expansion. The first two can cause intermittent operation only if some defect is already present in the set, but thermal expansion may produce it even if no defect exists.

INTERMITTENTLY DEFECTIVE PARTS

Fixed Condensers. Defective paper condensers are the most common causes of intermittent complaints. As you know, usually these condensers have only a pressure connection between their leads and the condenser plates. The ends of the leads are bent into a spiral shape and pressed against the edges of the plates, and are held in this position by the wax that seals the ends of the condensers. Obviously, the connection has little strength and can readily be broken by mechanical jars. Further, heat may soften the wax enough for a lead to move away from the plate with which it should be in contact.

When such a break between a lead and a condenser plate appears, the gap will be very small. It can, therefore, be closed or opened very easily, so an intermittent open in such a condenser can be expected to occur rather often. On the other hand, it is virtually impossible for a paper condenser either to short intermittently, or to change in capacity.

Almost any complaint can be produced by intermittent opens in a paper condenser—dead set, weak set, distortion, oscillation, etc. The complaint caused depends on where the condenser is used in the circuit.

► Many electrolytic condensers, in cardboard containers, are held in place by metal brackets. Sometimes leakage will develop between the condenser and the bracket through the cardboard. If this leakage varies intermittently, it will cause intermittent hum.

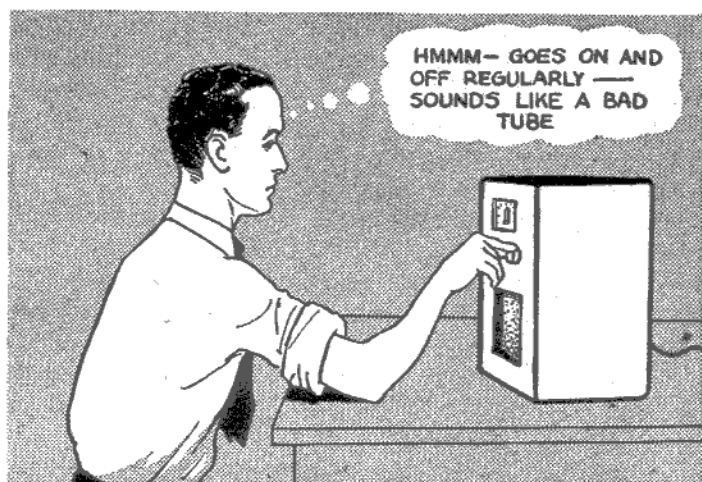
► Intermittent defects in other kinds of condensers are very rare.

Tubes. A defective tube is the second most common cause of intermittent receiver operation. As you might suspect, the filament is most often to blame. A filament gets hot in normal operation and may undergo considerable expansion. If it is broken, and the broken ends are touching, this expansion may cause the filament wires to pull apart at the broken point. This will open the circuit and shut off the filament current; consequently, the filament will cool off again and shrink back to its normal position. When the broken ends come together again, filament current will again flow, and the process will be repeated. Often it will be as regular as clockwork. Of course, the tube is dead for the length of time the filament stays open.

Improved manufacturing techniques have largely eliminated this trouble in tubes with low-voltage filaments. It is still quite common, however, in the tubes with higher-voltage filaments now used in a.c.-d.c. receivers.

► Heat expansion may also cause partial shorts in tube filaments, with one section of the filament touching another. High-voltage filaments are likely to have this trouble because of the many closely spaced loops of the filament.

The effect of a shorted filament is to produce weak reception. This defect is not always a regular on-and-off affair like an open filament, because the filament loops may remain shorted until the set power is turned off. However, the filament will then return to its normal state, and the tube will be good for a while after the set is turned on again.



If the set starts and stops with great regularity, a broken tube filament is probably to blame. Occasionally such operation may be caused by some other defect, however. A table later in this RSM Booklet gives a listing of other parts that may cause regular on-and-off operation.

Intermittent cathode-to-heater leakage sometimes occurs in a tube. Again, the defect is the result of movement of the filament as it becomes hot. This intermittent leakage can cause any of the defects usually caused by cathode-to-heater leakage — intermittent distortion, hum, or oscillation.

Tubes also exhibit other and more mysterious intermittent defects. These can usually be blamed on a defective weld between one of the tube electrodes and its lead. The heat of operation of the tube may cause the weld to open; the effect of this, of course, depends upon which electrode is at fault.

In general, an open filament is the only tube defect that is genuinely intermittent in the sense that it occurs at regular intervals while the set is playing. Other defects usually occur after the tube has become warm and do not cure themselves until power has been removed from the tube.

Coils. An open is the most common intermittent defect in a coil. An air-core coil may open up because the coil form expands, stretching the wire near a lug until it breaks. This may create a permanent defect, or con-

tact may be re-established if the chassis is jarred or the coil form returns to its normal size. The set will usually be dead while the coil is open. This defect occurs only with air-core coils—iron-core coils are not wound so tightly on their coil forms, and therefore do not break when the coil form expands.

When electrolysis attacks the coil winding, the result is usually a tiny break in the winding. The break may be so small that it opens and closes rapidly, in which case the receiver will be noisy. If the interval between opening and closing is somewhat longer, the receiver will be intermittently noisy; if the interval between opening and closing of the coil is rather long, the set will be intermittently dead. This defect usually occurs mostly in i.f. and audio transformers; power transformers are seldom affected.

Resistors. Defective potentiometers with carbon elements frequently cause intermittent complaints. Pitting of the carbon element causes imperfect electrical contact between the slider arm and the element; the slightest jar may break the connection. If the potentiometer is used as a volume control, any of several defects may occur, depending upon the circuit in which the control is used. Usually the complaint will be weak reception, noise, or hum.

Wire-wound variable resistors seldom become intermittently defective. Occasionally one will become dirty, permitting an intermittent contact to develop between the slider arm and the coil.

Fixed resistors may develop internal breaks that will make them intermittently defective, especially if they have been overheated. The intermittent complaint produced will, of course, depend upon the circuit in which the resistor is used; however, the most usual complaint is intermittent noise.

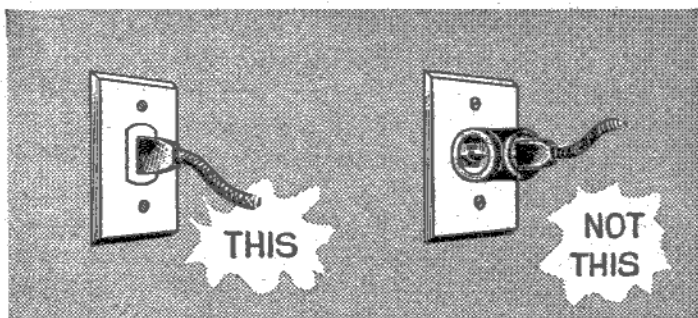
Tuning Condensers. A tuning condenser may be intermittently defective if a variable high-resistance connection develops in series with the rotor and stator plates. Usually this is caused by wiper spring contacts that are dirty or have lost tension. Many older receivers made the connection to the stator plates through bolts that held these plates properly centered between the

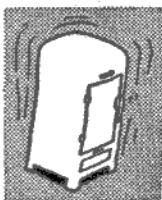
rotor plates. Oxidation of the threads on these bolts sometimes causes a variable resistance that produces intermittent operation. Metal particles sometimes peel off the plates of the older types of condensers, causing intermittent shorts between the plates. However, this defect no longer exists in modern condensers. Intermittent noise that occurs only as the tuning knob is being rotated usually indicates some defect in the tuning condenser gang.

Connections. Poorly soldered joints may open intermittently; sometimes, also, a bad soldering job will leave a drop of excess solder hanging from the connection and coming close enough to some other part of the set to cause an intermittent short. Any of several defects can be produced by a poor soldering job; intermittent noise or a dead set are two of the more common.

Installation Defects. Poor joints in the antenna or ground system are fairly frequent causes of intermittent reception. The poor connection may occur anywhere in this system, but the lead-in strip and the ground clamp are particularly common locations. The power connection may also be at fault, especially if the customer has plugged the power line into a cube tap along with several other appliances. A fault in the antenna or ground connection will usually cause intermittent noise or a dead set; a poor contact between the power cord plug and its receptacle will, of course, make the set intermittently dead.

Whenever possible, plug the power cord of a receiver directly into a wall outlet. Avoid using a cube tap if you can—they have a tendency to loosen inside and create poor contacts.





Intermittent operation is not always the fault of the receiver. Noise may be fed into a set by a refrigerator, an oil burner, a diathermy machine, a neon sign, etc. Intermittent fading on medium-distant stations often occurs around sunrise and sunset.



CONFIRMING THE COMPLAINT

Now that you know something about the more common defects that can cause intermittent operation, you are ready to learn how to isolate the trouble.

When you confirm the complaint, be sure to question the customer carefully. Remember—the radio may be playing all right at the time you come to examine it, so you can find out about intermittent defects only by careful questioning. When you discover the customer is complaining of a defect that comes and goes, determine just what does happen when the radio plays abnormally. That is, does the receiver fade out completely (become dead), does it distort, or have a hum, or just what does occur?

While you are listening to the receiver to try to hear the trouble yourself, try to find out how frequently the trouble occurs. Ask whether it happens as soon as the set is turned on, or only after the set has operated for a period of time.

Be particularly careful to inquire further into complaints that seem to occur at fairly definite times during the day or that seem to be related to the operation of household devices. These complaints may be caused by some external influence—an unshielded diathermy machine in a nearby doctor's office, for example, might be the cause of noise that occurred only during the doctor's office hours. Or a noise that occurs only when an oil burner or a refrigerator is operating probably means that the electrical system of the device is feeding noise into the power line.

As another example, the customer may complain of fading out of medium-distant stations. Further questioning may show that this fading occurs only at the hours near sunrise and sunset. It is entirely natural to

find severe fading on medium-distant stations at this time—even on stations that may be heard satisfactorily earlier and later—because of shifts in the ionized atmosphere layers that serve to reflect radio waves.

This initial questioning is necessary to determine whether the trouble is actually within the set. It is particularly necessary with intermittent noise and intermittent hum, both of which may be caused by man-made interference of an intermittent type. Atmospheric conditions may account for intermittent fading in and out of signals, and in some instances for distortion and perhaps station interference, which may be described to you as noise.

Once you are reasonably sure that the complaint is caused by the receiver or its installation, the next step is to be certain that the installation is not at fault. A break or a poor contact in the antenna system, or a poor electrical contact at the power plug, may cause severe noise or sharp changes in the volume. The set may even go intermittently dead because of such defects.

It is well to examine the antenna system carefully. Shake the lead-in wire to see if this makes the receiver act up. Be particularly careful in your examination of window lead-in strips.

In some cases of intermittent reception or intermittent noise, you may find that walking around in the room causes the trouble to appear and disappear. This can mean that the receiver is being jarred by your movements and thus shocked into and out of normal reception. However, don't overlook the fact that the installation itself can be at fault—walking around the room may make pipes touch under the floor in such a way that there is a better ground than normal (or in some instances a poorer ground than normal) for the radio.

Sometimes you will find that turning on or off electric switches causes sharp changes in the volume level of the receiver. This may mean that the operation of the switch is shocking the receiver back into normal operation. On the other hand, it may indicate that the set has a defective antenna and is depending for its operation on signals picked up by the power line. If so, opening or closing the switch will change the effective length

of this power-cord antenna and so cause the set output to vary.

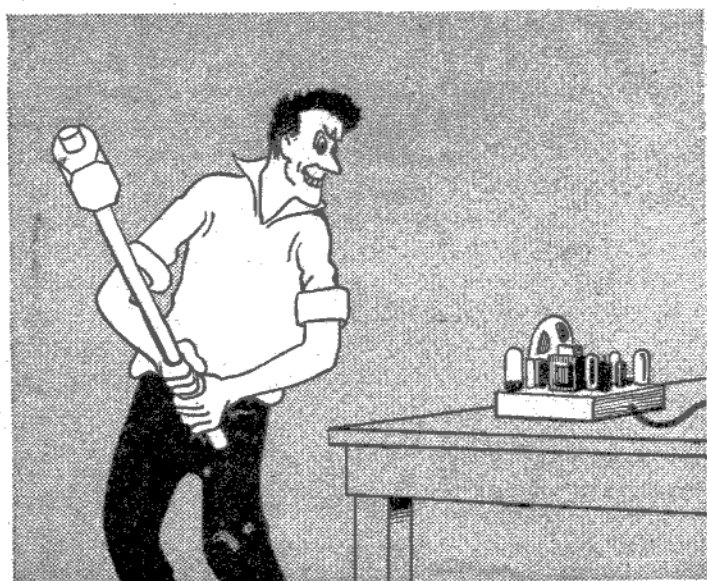
From what we have said, you can see that some judgment is needed to determine whether the set is at fault. Sometimes the only real test is to take the receiver to the shop and try operating it there. Naturally, if it continues to operate improperly in another location, the receiver must be defective. On the other hand, if the trouble clears up, there is a good possibility that the location or installation is at fault.

► However, let's suppose that the customer's description of the defect, or the operation of the radio, leads you to believe the set itself is at fault. The logical procedure for you to follow is the same as for any other trouble—try to localize the defective section, stage, circuit, and part. In each instance, you will be looking for a defect that could cause that same symptom more permanently—if the complaint is intermittent hum, for example, you would look for things that would cause hum, not for troubles that would cause distortion.

► Now for some general rules. The greatest difficulty with intermittent reception is the fact that a mechanical jar or an electrical shock may temporarily restore the set to normal. Therefore, your attempts to test and localize the trouble may shock the set back into normal operation, thus forcing you to wait for the next occurrence of the trouble before you can continue your tests. This makes it practically impossible to perform any kind of circuit disturbance test, because such a test is almost certain to restore normal operation, whether the defect is in that stage or not. Therefore, either you must follow a brute force technique of trying to *make* the trouble occur, or you must use test procedures that will not shock the set back into operation. We will describe both methods, brute force first.

BRUTE FORCE LOCALIZATION

The brute force method is given that name because it is the application of physical force to the set in an attempt to make it act up. To use it, you wiggle the various by-pass condensers, pull on leads, snap tubes with your finger, and jar the chassis. Naturally, you



In spite of the name, this is NOT what we mean by "brute force" localization! Radio parts are fairly delicate—don't strike or pull them hard enough to injure good ones.

must use some discretion—don't yank leads or parts hard enough to break them, but use enough force to open up any connection that is already loose.

If the set is sensitive to jarring, so that striking the chassis causes the intermittent action to show up, then rap more lightly in different places on the chassis. If you find that one end of the chassis is much more sensitive to this jarring than the rest of the chassis, very likely that is the end where the defect is; concentrate on jarring the individual parts there until you are led to a logical suspect.

When the trouble is an intermittent contact in a tube, you will find that rapping lightly on the tubes, one at a time, will disclose the offender. Of course, always keep in mind the possibility that the jarring you introduce by doing so may actually be moving a defective part or connection somewhere else—a loose connection at the tube socket, for example. For that matter, there is always a chance that you are unknowingly jarring some remote part or connection when you use any brute force technique. However, if you find that moving a

part or pulling on a lead lets you make the intermittent condition appear and disappear at will, then you should first suspect the part or circuit you are touching. Replace the part, or resolder connections, to see if the intermittent operation disappears. If it does not, you should then consider the possibility that your actions jarred the set at some other point.

If you cannot force the trouble to occur easily by the brute force method, go on to other methods of testing that we will now describe. We will show how to locate the defect in an intermittently dead or intermittently weak set first, because these are the most common intermittent complaints.

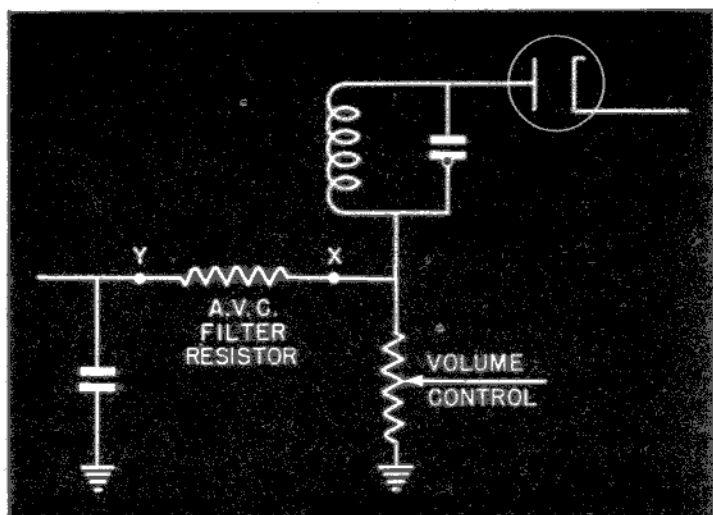
LOCALIZING THE TROUBLE IN A RECEIVER THAT IS INTERMITTENTLY DEAD OR WEAK

When you are called upon to service a receiver that is intermittently dead or weak, the first thing to notice is the tuning indicator, if the set has one. Any changes in the signal level up to the second detector will be shown by a change in the closure of the tuning eye, or by movement of the tuning meter pointer. Any such changes at once indicate that the trouble is in the r.f. section of the receiver, or in the power supply.

If, on the other hand, the tuning indicator indicates that the signal volume level remains constant, but the set becomes weak or goes dead intermittently, the trouble must be in the audio amplifier.

In the latter case, coupling condensers and tubes are the most logical suspects. However, if the trouble could be in either the r.f. stages or the power supply, you should measure the power-supply voltage first. If it does not vary, tubes are the next most likely suspects.

► If the set has no tuning indicator, provide one. The quickest and simplest means of doing this is to connect a d.c. voltmeter so that it will indicate the a.v.c. voltage. Connect the meter, and *allow it to remain connected* until the set has had a chance to act up. (It is not a good idea to take a reading, then disconnect the meter and come back and take another reading when you think the signal level has changed. If you try this, connecting the voltmeter may draw sufficient current to provide the



This diagram shows two points to which you can connect a meter to indicate a.v.c. voltage in a set that uses the volume control as the diode load, as do most modern receivers. It is usually simpler to connect your meter from point X to ground (that is, across the volume control). However, doing so will affect the tone and the output of the set; also, you must be sure your meter will not indicate a.c. Either a high-resistance or a low-resistance meter can be used. Connecting your meter from point Y to ground will not affect the performance of your set, and it does not matter whether the meter indicates a.c.; however, you must use a high-resistance meter. In either case, the positive meter terminal should go to ground.

needed shock to start the receiver operating again. You won't know then where the trouble might be.)

With the d.c. voltmeter connected to the a.v.c. circuit, allow the receiver to operate. When the fading occurs, notice whether the d.c. voltage reading has changed. If it has, the defect must be in the r.f.-i.f. section or in the power supply. Otherwise, it is in the audio amplifier.

When you have located the defective section in this way, you may decide to revert to the brute force method of finding the trouble, or you may go to what you consider the most logical suspect for the particular complaint. If you find it necessary to make further tests to locate the defective stage, remember that you cannot use circuit disturbance techniques.

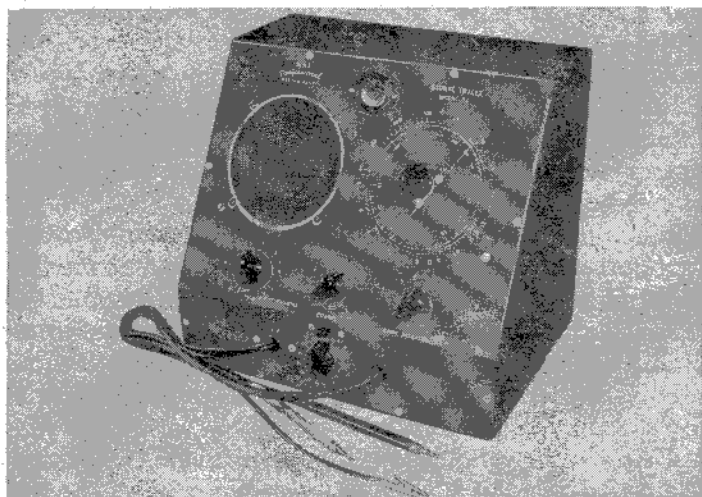
Using a Signal Tracer. If you have a signal tracer, the problem is not so difficult. You can connect the sig-

nal tracer and leave it connected until the fade occurs. If the volume drops in the signal tracer output as well as in the set output, you know the trouble is between the antenna and the point where the signal tracer is connected. On the other hand, if the signal tracer maintains normal volume but the set output drops, then the trouble is between the signal tracer connecting point and the loudspeaker.

Because a signal tracer indicates the *amount* of signal at the point of connection, it is an ideal instrument to use when the complaint is an intermittently dead or intermittently weak set. You have your choice of methods—start with the signal tracer somewhere near the middle of the set and work towards the end containing the defect, or start at either end of the set and work back towards the other. From a logical standpoint, it is best to locate the defective section first, so the signal tracer is normally connected at the input of the audio amplifier. Any change in the amount of signal at this point indicates trouble in the r.f. stages or in the power supply.

There is one important fact you should consider be-

A signal tracer like this NRI Professional Model 33 is an excellent instrument for servicing intermittently defective radios. However, since a signal tracer is such a generally useful test instrument, you may prefer not to tie it up in servicing an intermittent set unless the intermittent operation occurs fairly often.



fore you start to use a signal tracer—or, for that matter, any other piece of test equipment—to locate an intermittent defect. You must leave it connected until the set acts up. Therefore, your test equipment is tied up to this intermittent receiver. You cannot use it to service other sets while you are waiting for the defective one to act up. For this reason, be sure to learn how often the intermittent defect occurs before you even accept the job. If it is relatively infrequent, it may be best to advise the receiver owner to keep his set until the trouble occurs more often. Point out to him that, at the moment, the repair will cost him more than it is worth because of the time you will have to spend looking for the defect. However, if the intermittent occurs several times an hour, then it is becoming frequent enough to consider tying up equipment to locate the defect.

Of course, in between cut-outs, you need pay little attention to the set. Service other receivers, or attend to other shop duties, as long as you stay within hearing distance of the intermittent set. When you hear the set act up, a glance at your indicator will show you how much progress you are making in locating the trouble.

Signal Injection. If you do not have a signal tracer, you will undoubtedly depend mostly on the brute force method when the defect is in the audio system or in the power supply. R.F. troubles, however, are sometimes difficult to locate by force. If you have a signal generator that operates from the a.c. power line, you can use the following method of signal injection to locate the defective stage:

Tune the set to a quiet point on the dial (no signals), connect the signal generator to a signal circuit in the set, and tune the s.g. to a frequency that will pass through the set at that point. Turn down the s.g. output so that it approximates the strength of a normal signal at the particular point where the s.g. is connected to the radio.

Allow the s.g. to run until the set acts up. (Unfortunately, this means that you must listen to the very monotonous tone of the signal generator for some time—one good reason for not accepting an intermittent that

does not act up reasonably often.) If the s.g. signal fades, then the defect must be somewhere between the point where the s.g. is connected and the output of the set. On the other hand, if the signal remains constant, the defect is in some stage nearer the antenna.

To make sure you will hear the fading, start with the signal generator connected to the antenna terminal. Then, advance your s.g. toward the loudspeaker a stage at a time. When you finally reach a point where the fading no longer occurs, you have just crossed over the defective stage.

OTHER INTERMITTENT COMPLAINTS

Fading and weak reception are the most common intermittent complaints, but hum, oscillation, noise, and distortion also occur intermittently. In each of these complaints, you can again use the brute force method, concentrating on the particular parts that are most apt to be at fault. Table 1 lists the most common causes of these intermittent complaints.

Intermittent hum is almost always caused by intermittent cathode-to-heater leakage in a tube, or by a leaky electrolytic filter condenser. Once in a great while, a grid circuit may open intermittently, and there may be cases of intermittent modulation hum. However, you should concentrate first on tubes and filter condensers.

Because of the intermittent nature of the trouble, the standard tube test is not always satisfactory. A much better test is to substitute tubes for those in the set. Some servicemen make a practice of putting in an entire new set of tubes, then putting back in the old tubes one at a time until the trouble reappears. Other servicemen work the other way, replacing the tubes one at a time with new ones until the intermittent operation stops; then the last tube replaced was defective. Either method will show you which tube is bad. However, the latter method may be somewhat quicker if you concentrate on first replacing the tubes that are most likely to cause the trouble. For example, in intermittent hum complaints, replace the audio and power output tubes first, since they are the ones that are likely to be at fault.

► Intermittent distortion is an audio defect in most

cases. This trouble is most likely to be caused by gassy tubes, intermittently leaky coupling condensers, and intermittent short circuits that change supply voltages.

These conditions can be checked for with a d.c. voltmeter. Make the same tests that you would make for a permanent defect, but leave the voltmeter connected until the distortion occurs, and then check to see whether the voltage has changed. You can leave the d.c. voltmeter connected across the grid resistor, for example, to determine whether a gassy tube or leakage in the coupling condenser is to blame. (With a signal tuned in, you may observe small variations in the voltmeter reading. Ignore these—when the distortion occurs, the reading will be radically different.)

Similarly, you can connect a d.c. voltmeter and see whether there is any change in the supply voltage when the intermittent defect shows up.

► Intermittent noise and intermittent oscillation can be run down by brute force methods, by signal injection, or by the use of a signal tracer. The last is generally the best. Just listen to the signal through your tracer; as long as it has the oscillation or noise voltage added to it, the trouble is between the antenna and the point where your tracer is connected.

ADDITIONAL CLUES TO THE SOURCE OF TROUBLE

We have already mentioned the tuning indicator as

TABLE 1

Complaint	Most Probable Cause
Hum	Cathode-to-heater leakage, leaky electrolytic filter condenser.
Distortion	Gassy tube, leaky coupling condenser, short in voltage-supply circuit.
Noise	Tube with loose elements, poor connection, open in i.f. transformer primary.
Oscillation	Loose shield, changes in tube characteristics, open electrolytic condenser.

a means of localizing the trouble when the complaint is intermittently dead or intermittently weak reception. The tuning indicator may sometimes also indicate when noise occurs in the r.f. section or the power supply, because the meter needle or tuning-eye shadow may quiver in step with the noise pulses. However, this is not very reliable, because a severe trouble in the audio amplifier may pass a noise voltage through the power supply to the r.f. stages. Always remember that such interconnections exist—they cause some of the most baffling defects.

► Another important fact is that the rapidity with which the defect repeats itself is often a clue to its nature. As we pointed out earlier, heat is frequently the cause of intermittent operation. If a part is made defective by heat, and can heat and cool quickly, the time interval between periods of improper operation may be short. On the other hand, if the part is a large heavy one, it may take some time for it to heat up. In this case the trouble won't occur until some time after the receiver has been in operation, and then may not recur very rapidly.

For example, when the defect is an intermittent open in the filament of a tube, the filament heats quite rapidly when the connection is made, and cools equally fast when the break occurs, with the result that the interval of time is short. If, on the other hand, the defect is an intermittent open in a power transformer winding, there is so much metal in the vicinity to be heated and cooled that the defect will take longer to appear and longer to disappear. Table 2 indicates several probable causes of trouble when the intermittent occurs at regular, definite intervals of time.

Sometimes a serviceman is baffled by the fact that the set plays intermittently while in its cabinet, but plays rather satisfactorily, with far fewer cut-outs, when it is placed on his bench. This is almost always an indication that for the trouble to occur, the set must be enclosed so that enough heat is trapped. You can frequently get around this by enclosing the set on your workbench in a cardboard box. This will cause it to heat up much faster, and the trouble will therefore occur sooner.

TABLE 2

Time	Probable Cause
0-3 minutes	Defective connection.
3-5 minutes	Defective resistors, especially cathode bias resistors which heat up after tubes are warm, and other parts that dissipate heat rapidly; loudspeaker fields are in this classification.
3-5 minutes	(A.C.-D.C. receivers.) Series filament resistors and heavy duty bias resistors that sag and touch the chassis.
Over 5 minutes	Defective power transformers and large resistors.

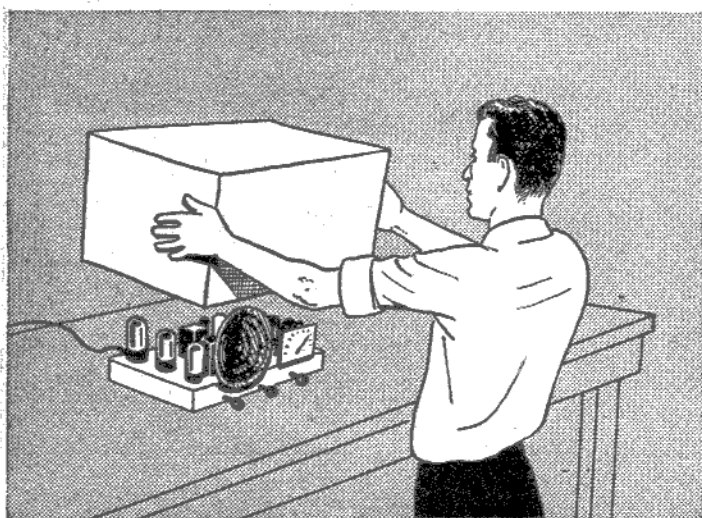
NRI PRACTICAL TRAINING PLAN

It is perfectly possible to introduce defects that will make a receiver dead, weak, noisy, distorted, or will cause it to hum. However, it is not practical to make these defects occur intermittently, since it is not possible to create the same types of intermittent shorts or opens that occur naturally in receivers. Because of this, wait until you have an intermittent receiver to service to get your practice.

When you have such a set to service, try every means of localization at your command. Get your practical experience on the job. Then, when you have learned all you can from this set, repair the trouble and go on to the next one. Remember, however, always to destroy any intermittent tube or other part you remove from a radio receiver. This will eliminate the possibility of its ever getting into another set.

► If you have followed the NRI Practical Training Plan faithfully up to now, you have received, in a few weeks, the practical training that would otherwise have taken you months or even years to acquire. You are certainly ready to cope with any ordinary receiver trouble.

Except for a few suggestions here and there in later RSM Booklets, this is the last of the sections on getting practical experience. If you wish to experiment further, it is advisable to repeat this entire Plan on another



To make a set heat up on your bench, simply place an ordinary cardboard box over it. Make sure the box is large enough to rest on the bench all around the set.

entirely different make of receiver. This will help greatly, because you will find that receivers do not sound exactly alike when they have distortion, and hum has different characteristics in different radios. Practical experience on more than one set is therefore desirable.

Looking Ahead. With this RSM No. 29 you have reached another milestone; this is the last of the series dealing with servicing for particular complaints. You will next receive RSM Booklets on servicing particular *types of receivers*, such as a.c.-d.c., auto, etc. Then you will finish the RSM series with No. 35 on "How to go into Full-time Servicing." There are no RSM Booklets beyond No. 35. However, if you have chosen the Lessons specializing in Radio Servicing, you will continue your education in this field by studying the advanced service methods in your regular Lessons.